Using the FLOWBEC seabed frame to understand underwater interactions between diving seabirds, prey, hydrodynamics and MREDs

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NE/J004308/1, NE/J004200/1, NE/J004332/1
NERC MREKE Internship
Innovate UK KTP / MeyGen Ltd.

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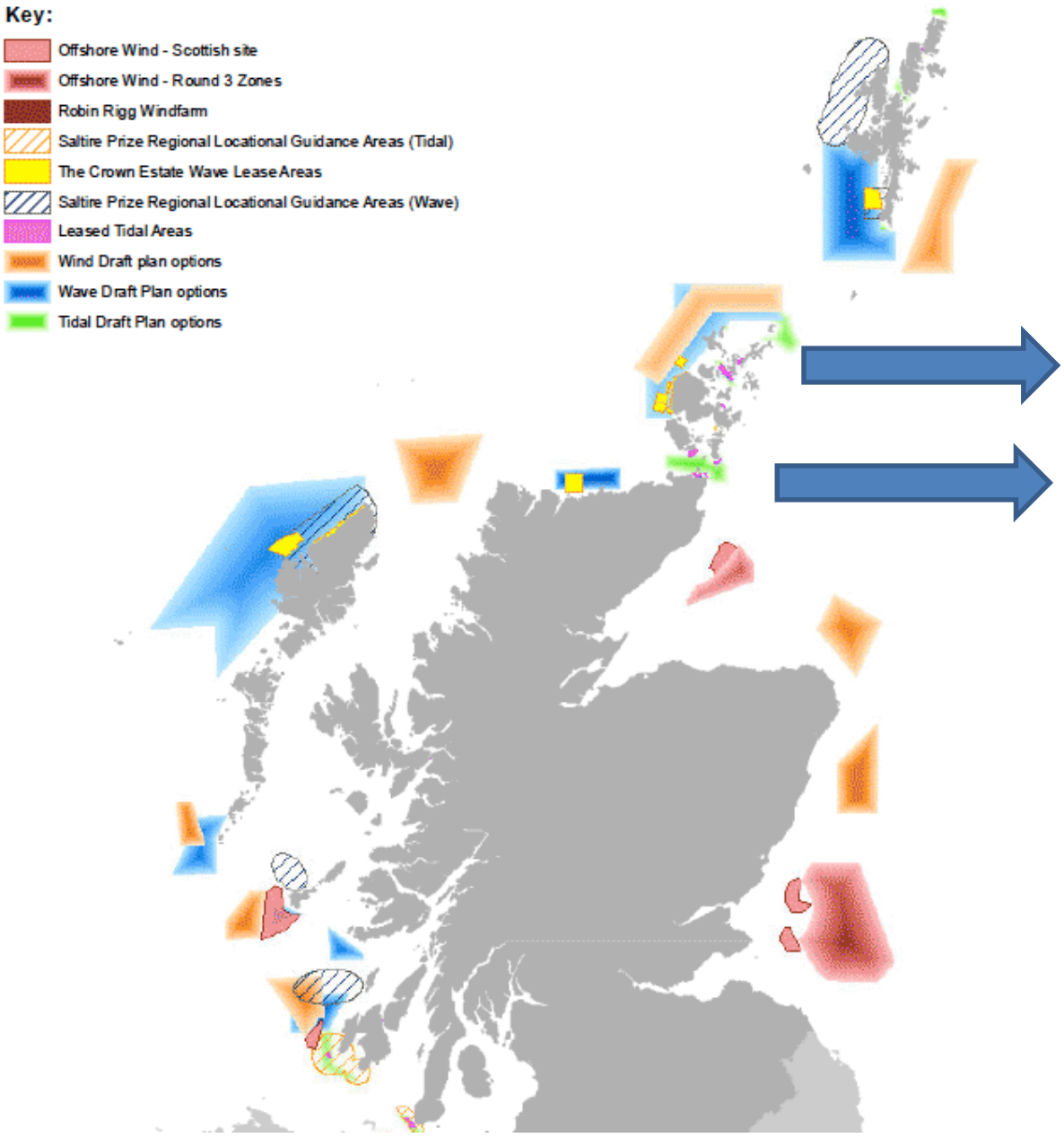

Scotland:

100% renewable by 2020

≈67.2% as of 2014

EMEC ORKNEY
The European Marine Energy Centre Ltd

MEYGEN
THE TIDE OF CHANGE IN CAITHNESS

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FLOWBEC Frame

- **Entire water column** (plankton, fish, seabirds, marine mammals)
- Captures **movement, behaviour and interactions** with MREDs
- Self-contained, portable between sites
- Continuously samples spring/neap 2-week period
- Complemented by concurrent:
  - hydrodynamic model data
  - above water radar and bird observations

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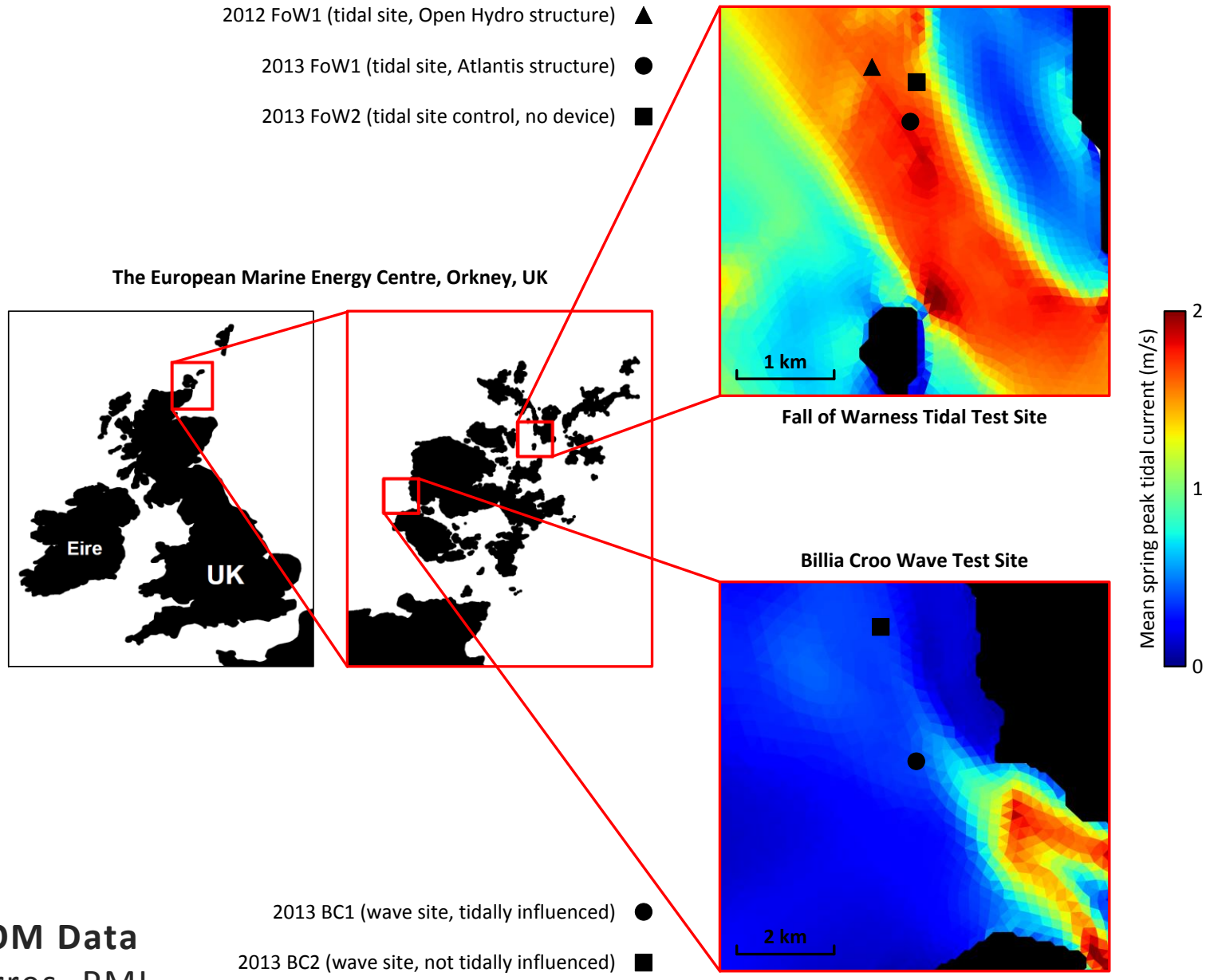

FLOWBEC FVCOM Data

Cazenave & Torres, PML

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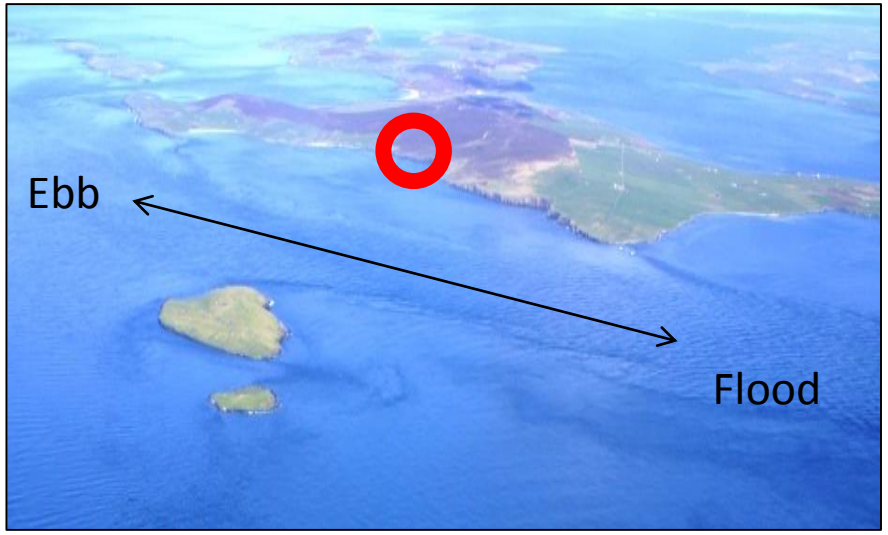
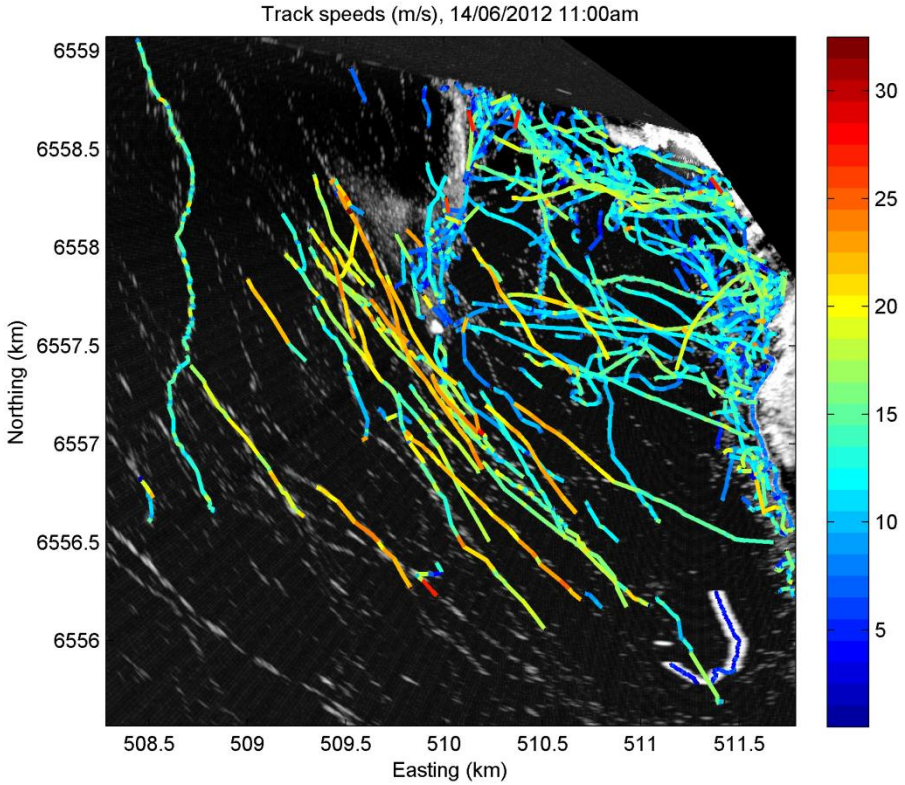
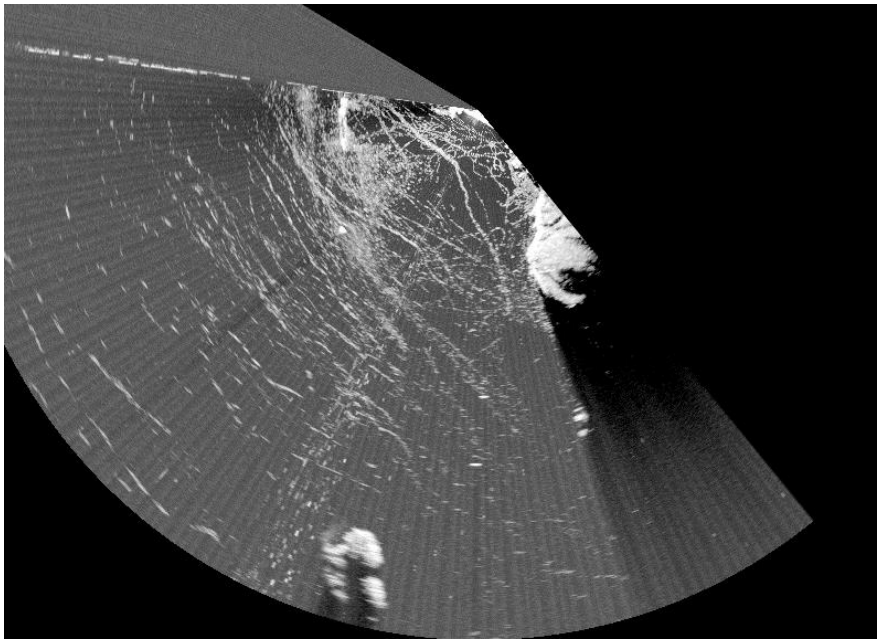
Marine X-band Radar (Bell and McCann)

- Sea-surface currents and roughness
- Target tracking (birds, mammals)
- Live stream noc.ac.uk/project/flowbec







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Simrad EK60 echosounder (38, 120, 200 kHz)

- bird and fish abundance, school behaviour
- multi-frequency target identification
- morphology of turbulence, plankton

Imagenex multibeam sonar (260 kHz)

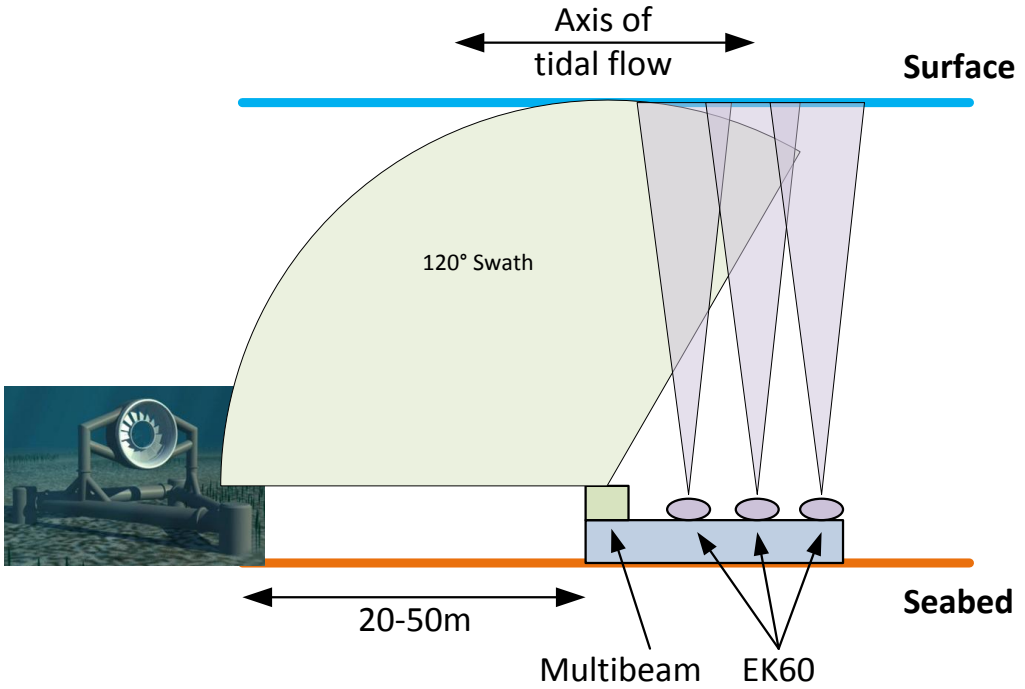
- interactions of fish, diving seabirds, marine mammals with MREDs
- target tracking, evasion behaviour

ADV

- flow, turbulence, temperature, water height

Fluorometer

- chlorophyll (phytoplankton)
- turbidity



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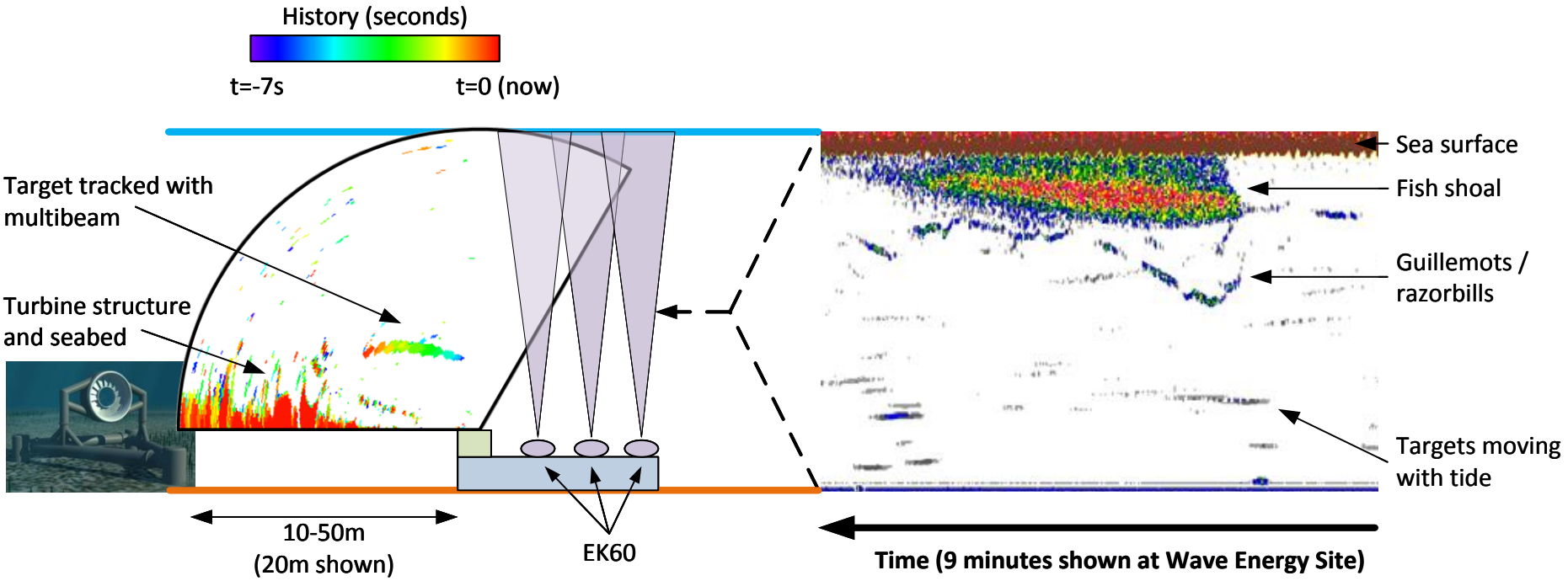
Multibeam for target tracking

EK60 for multifrequency ID



Acoustic classification ground truthed by shore observations

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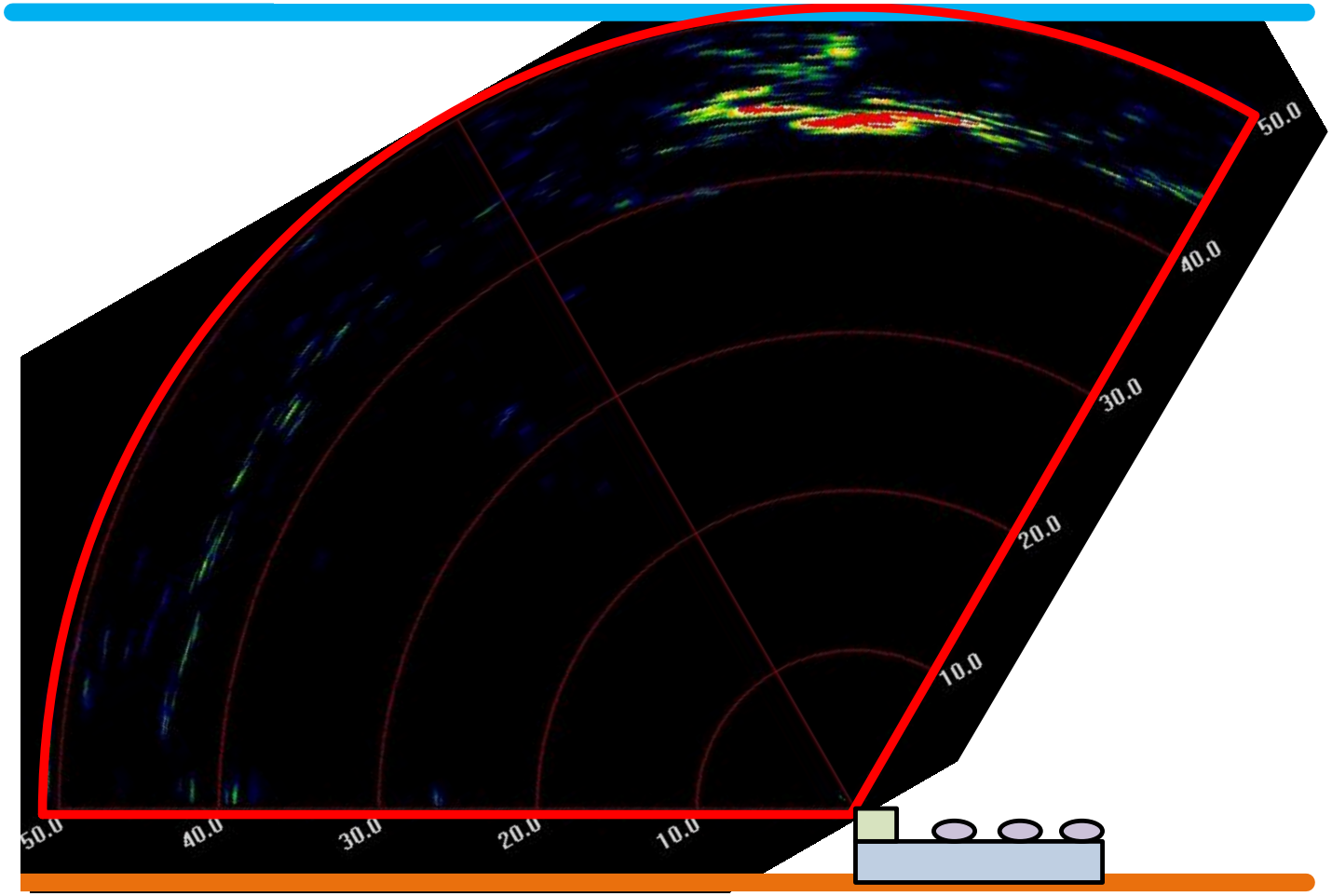
Multibeam sonar tracking of diving guillemots/razorbills feeding beneath a fish shoal at a wave energy site



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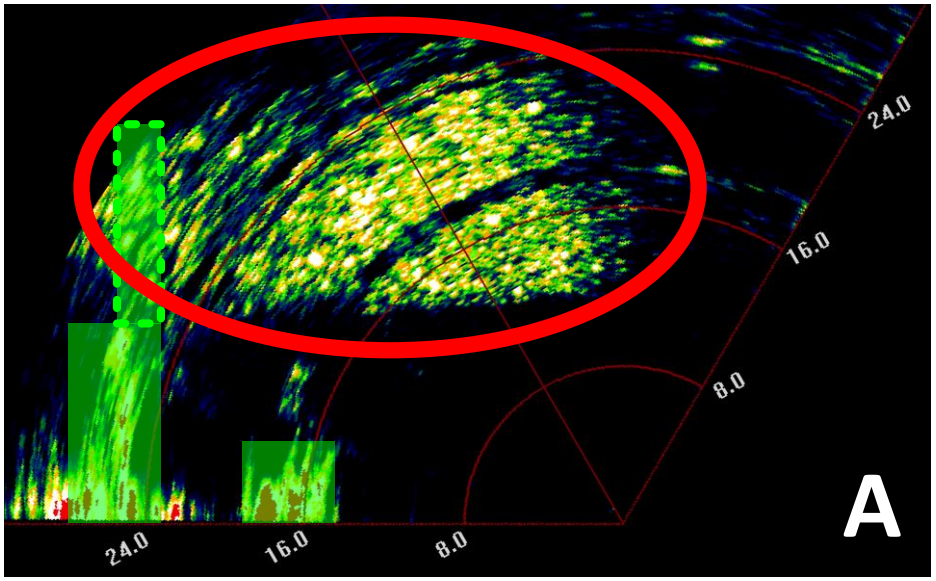
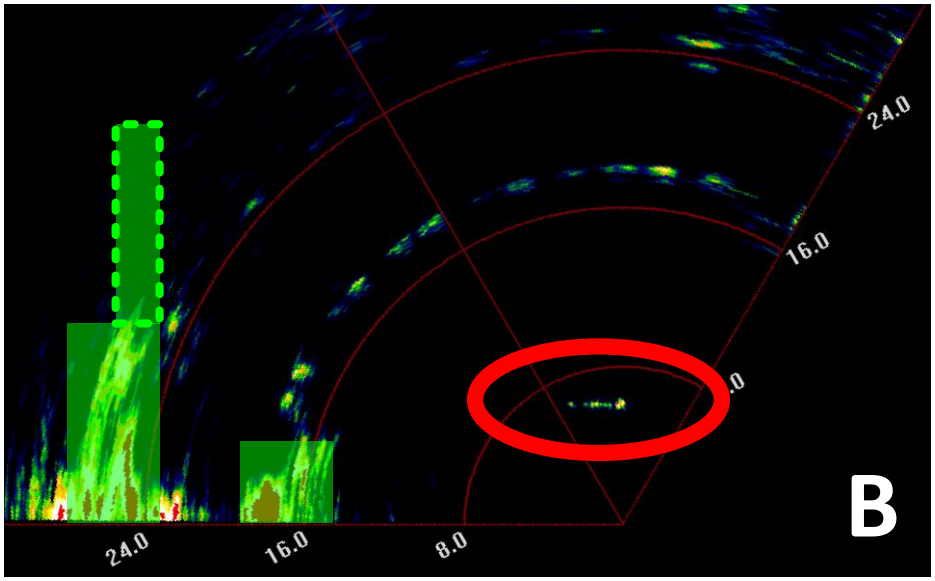
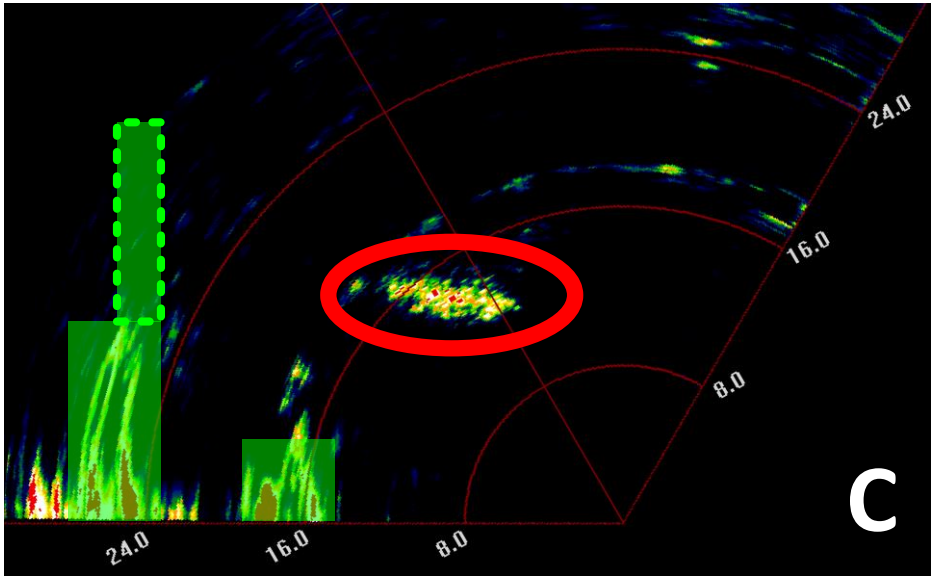
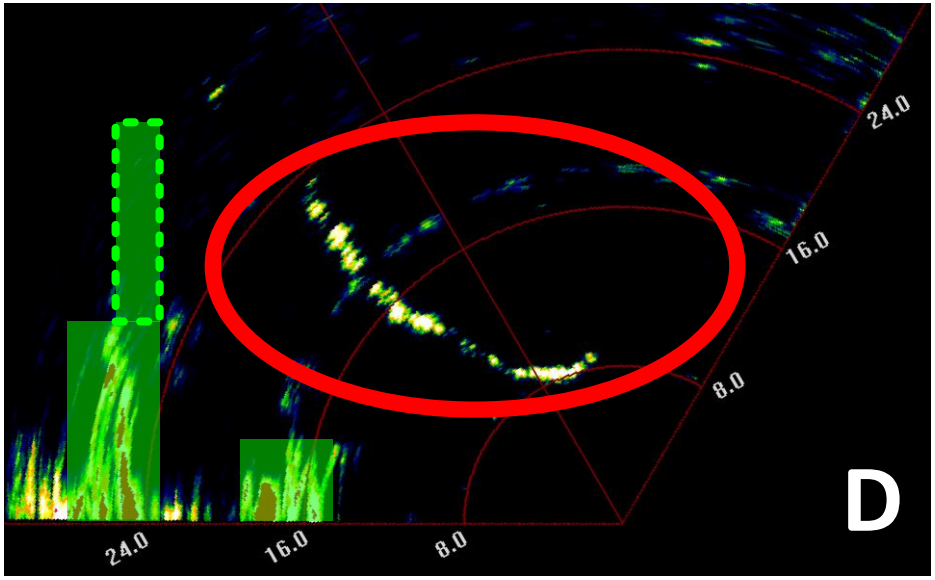
Green = Turbine structure, **Dashed** = Expected blade radius









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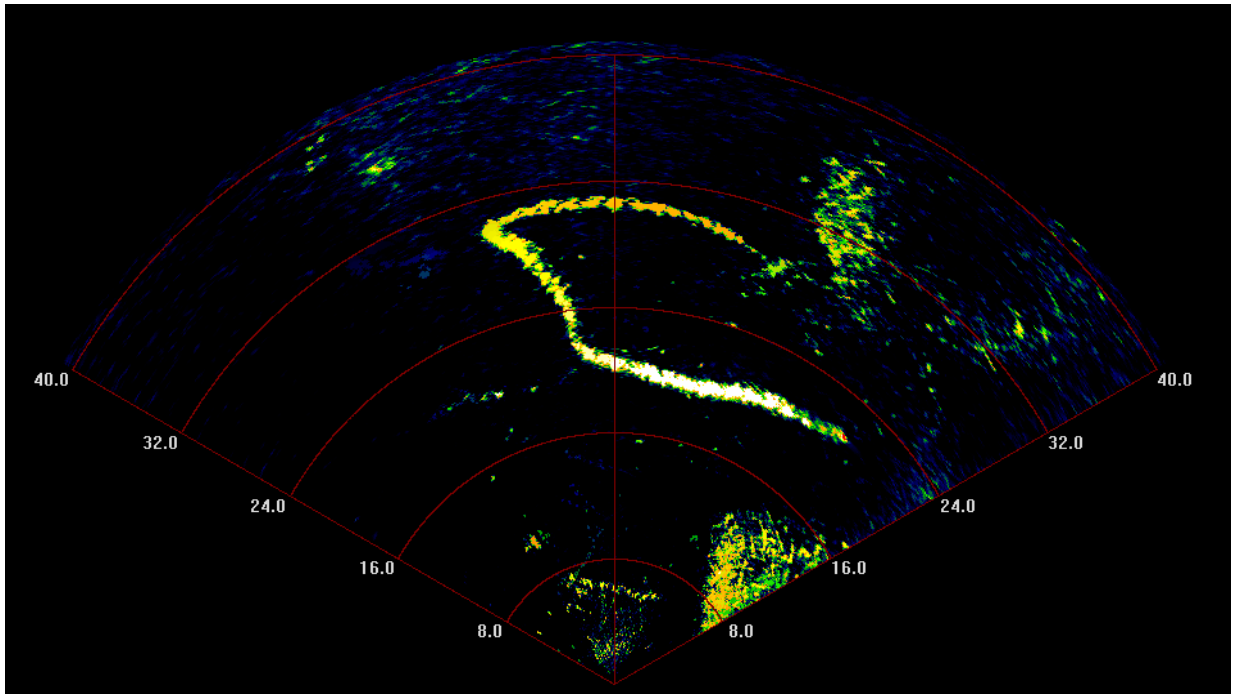
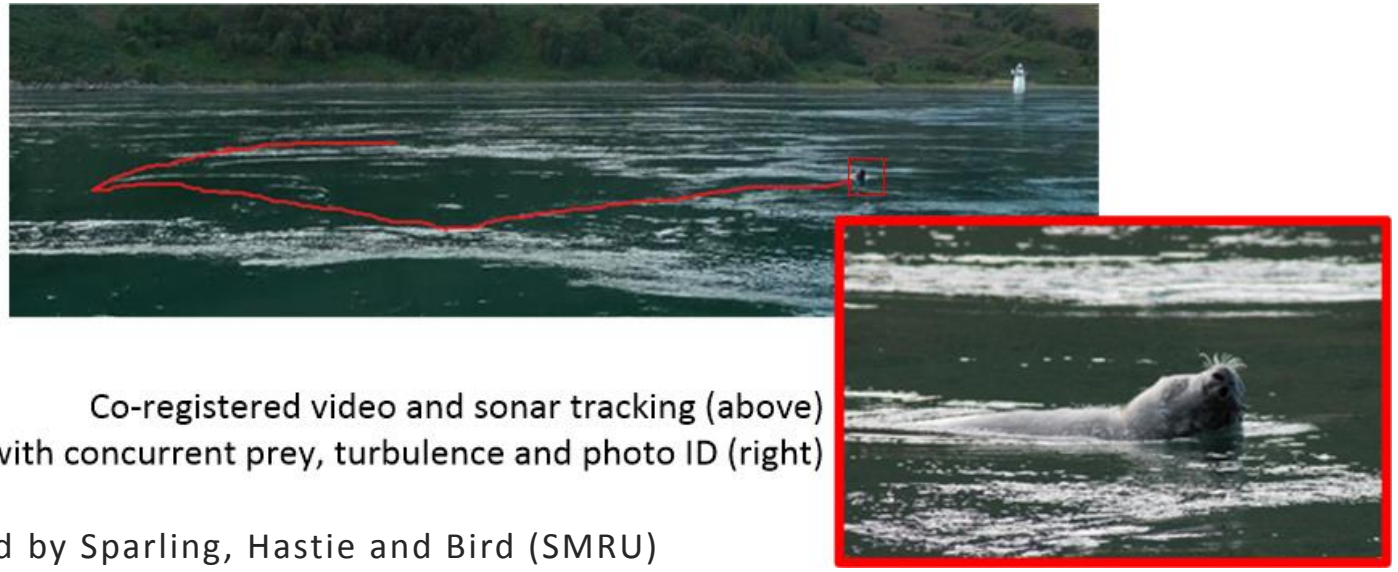


Multibeam sonar
3D seal and prey tracking
at tidal passes



Co-registered video and sonar tracking (above)
with concurrent prey, turbulence and photo ID (right)

Surveys facilitated by Sparling, Hastie and Bird (SMRU)

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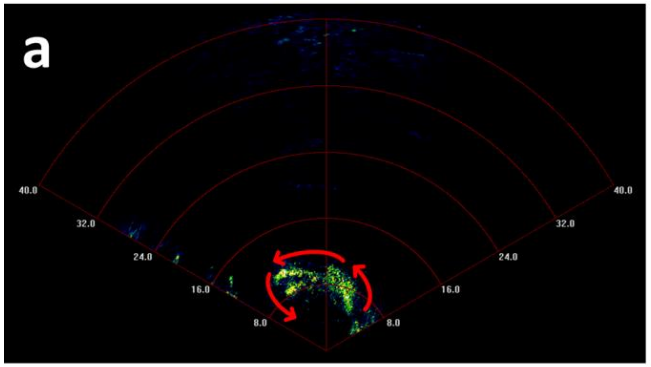

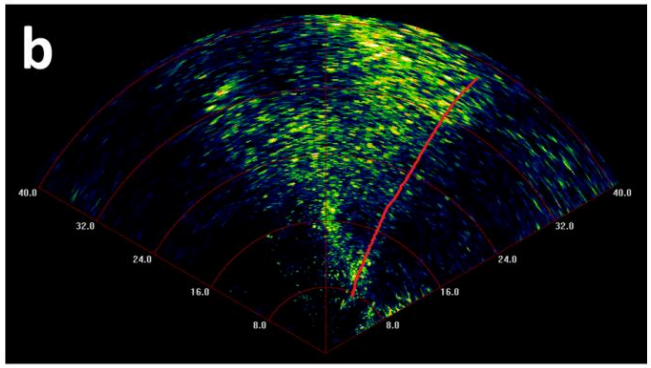

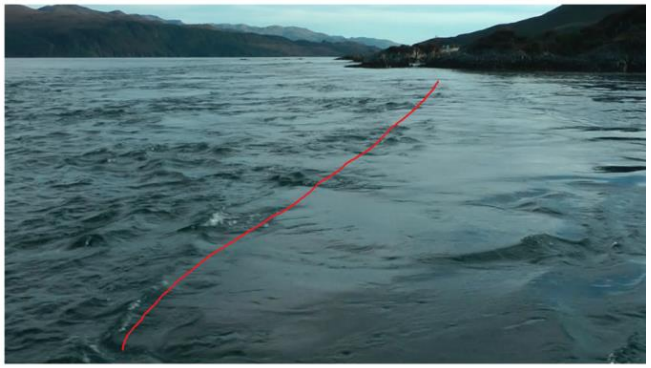

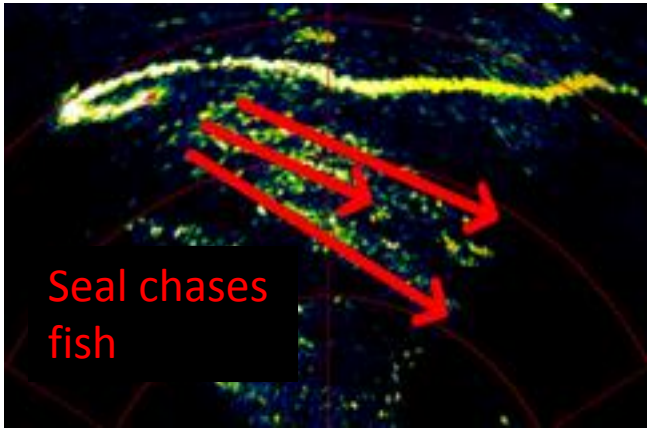

Concurrent video/sonar of predator-prey interactions and ecologically-relevant turbulent features

Surveys facilitated by Sparling, Hastie and Bird (SMRU)

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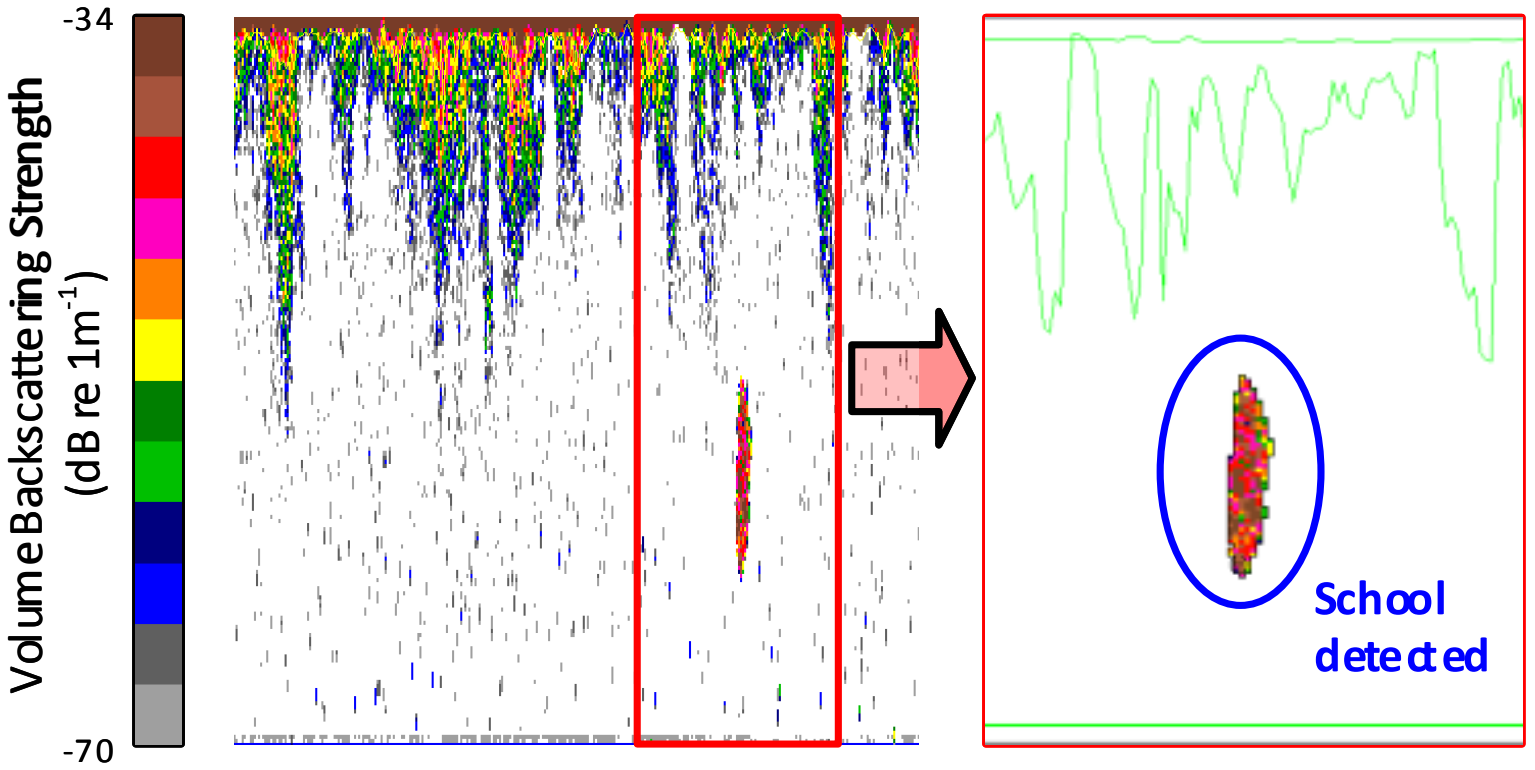
Turbulence mask and parameterisation:

- excluded from biological data, useful as a covariate

School detection:

- quantitative parameterisation of biological targets



Fraser *et al.* (2014) EIMR

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FLOWBEC target tracking

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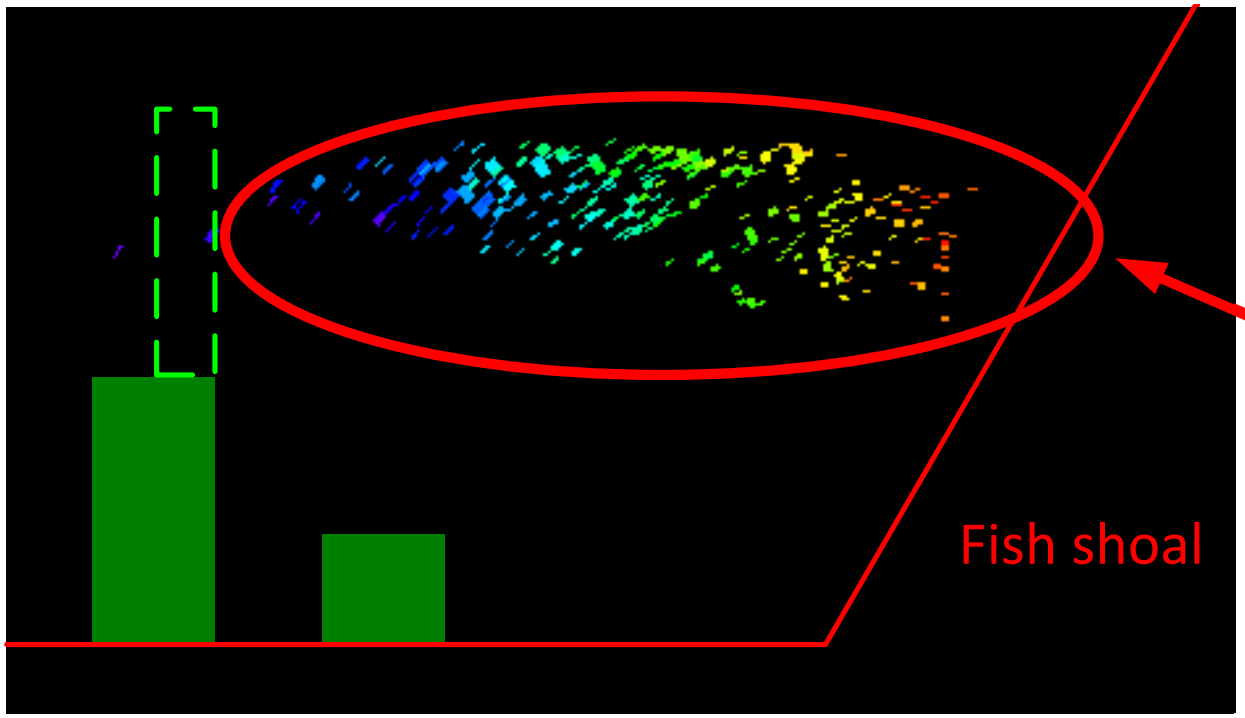
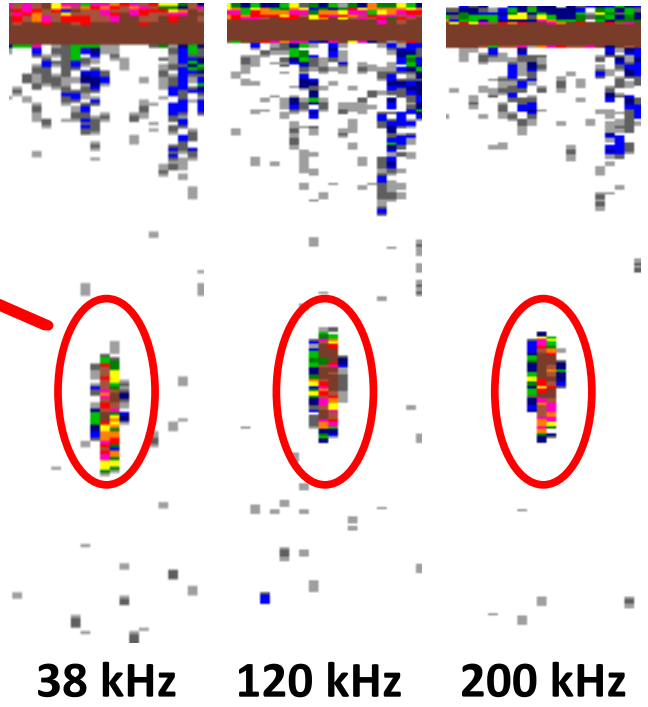
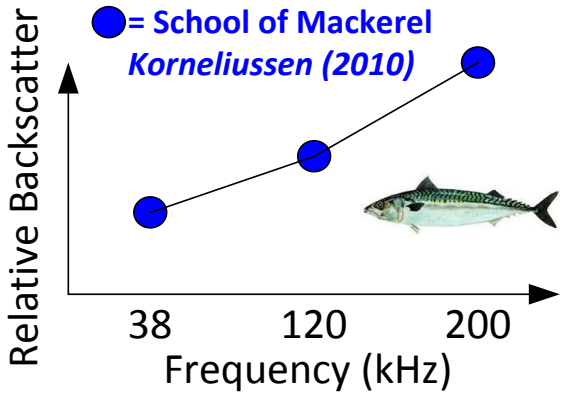
Green = Turbine structure, **Dashed** = Expected blade radius





- **Target detection** using the multibeam **and EK60**
- **Target tracking** using the multibeam
- **Multifrequency analysis** using the EK60



Target vertical distribution

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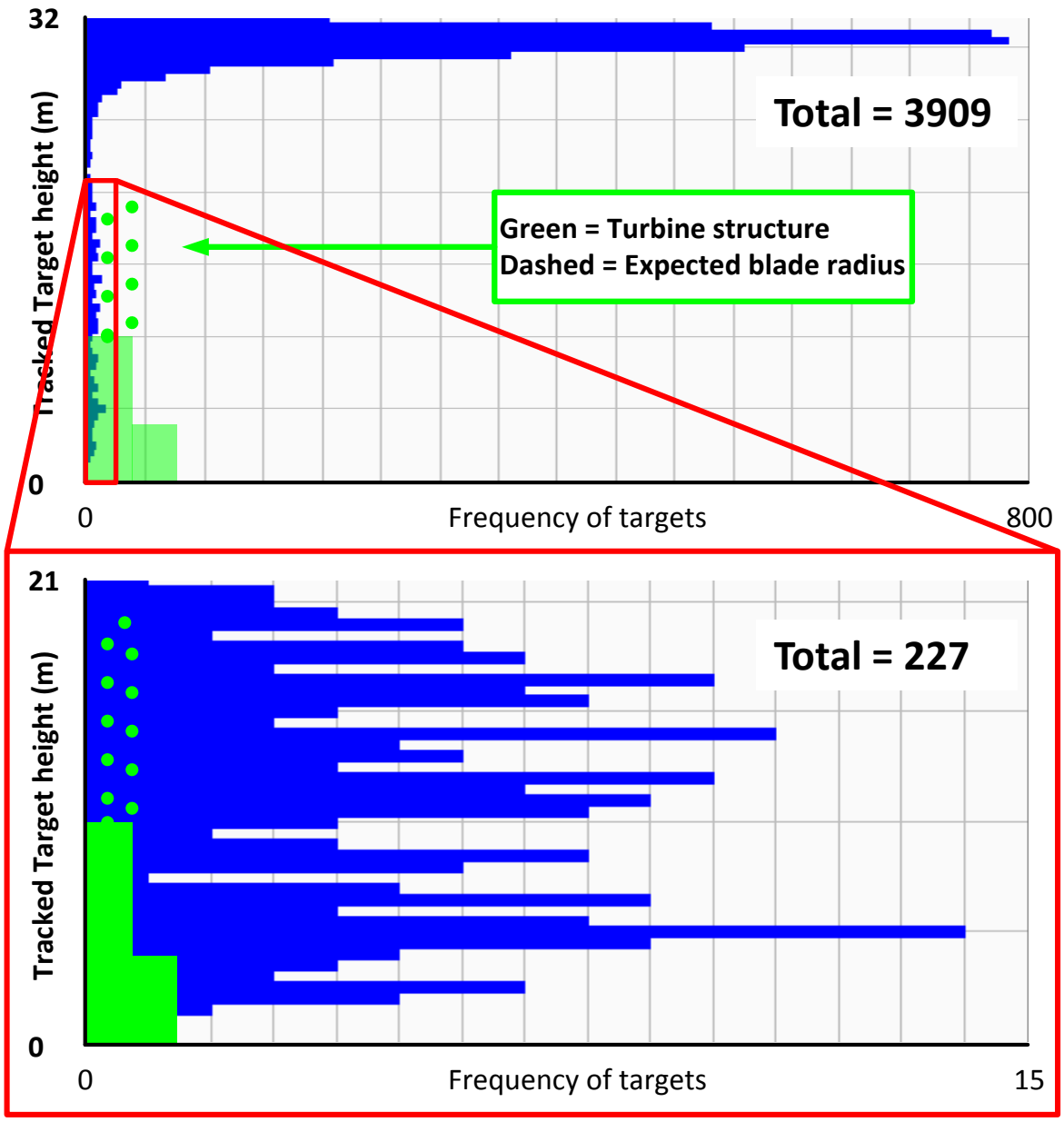
All tracked targets (mammals, birds, fish schools, individual fish) next to Atlantis turbine structure = 3909 tracks over 2 week period



Vertical overlap with turbine height = 227 tracks over 2 week period

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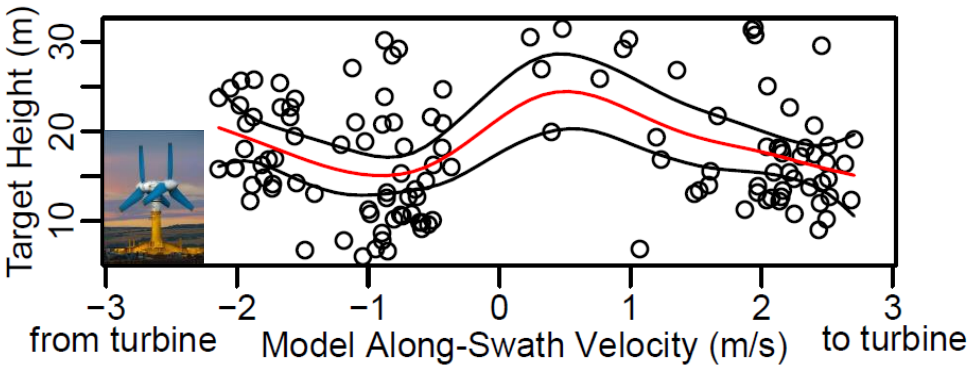
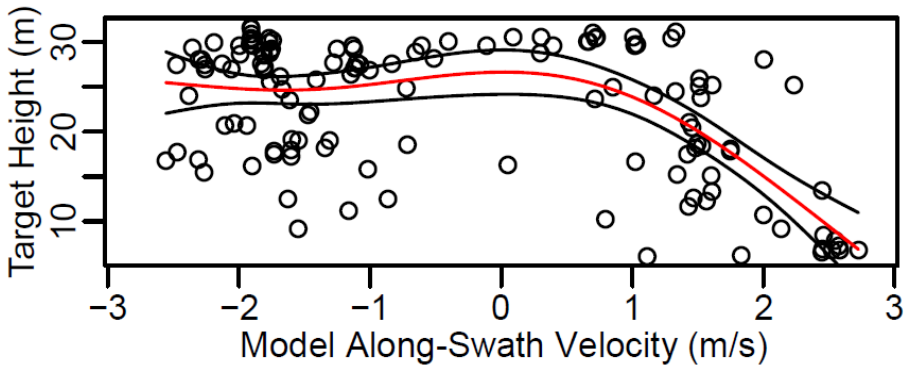
Co-registered MBES (behaviour and turbine interaction) and **EK60** (multi-frequency and turbulence metrics)

Turbine Structure



Control Site (no turbine)



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Ecologically-relevant turbulence

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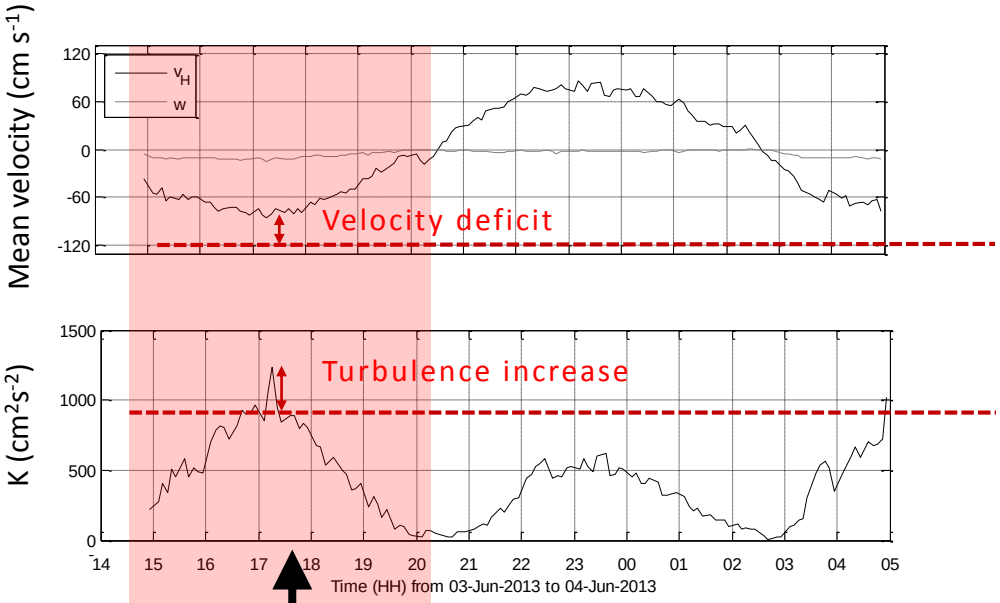
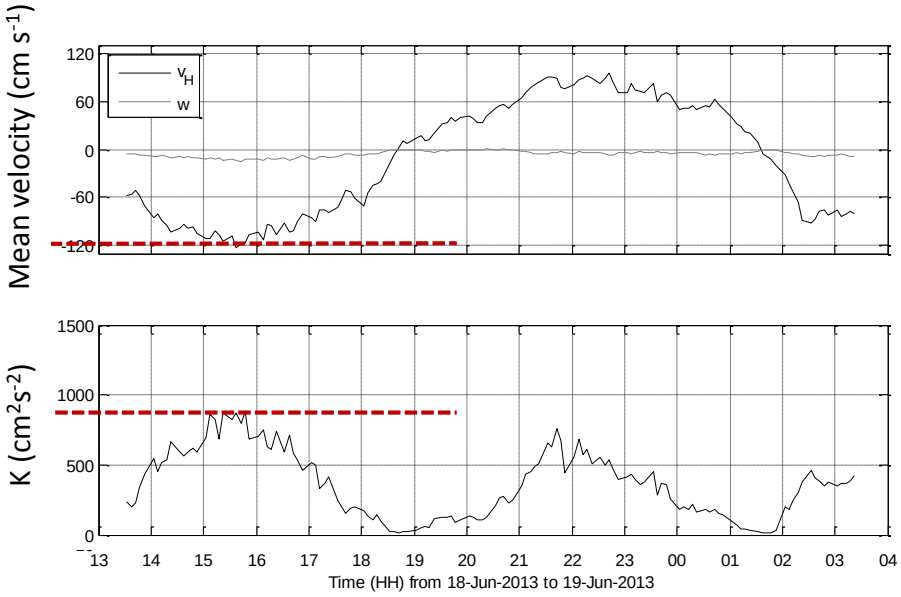
Turbine Structure



Period in turbine structure wake

Control Site (no turbine)



- Comparable hydrodynamic conditions
- Velocity *deficit* when in structure wake (ADV)
- But TKE (typically correlated with velocity) is *higher* in wake
- Suggests different mechanism (smaller-scale intense turbulence rather than natural larger-scale turbulence)

Fraser *et al.* (2014) EIMR

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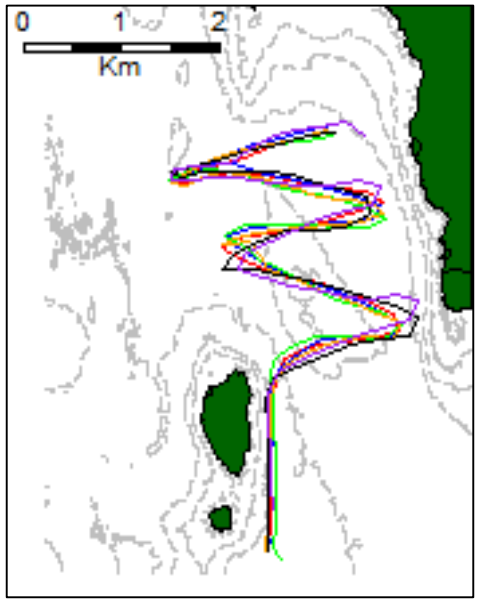
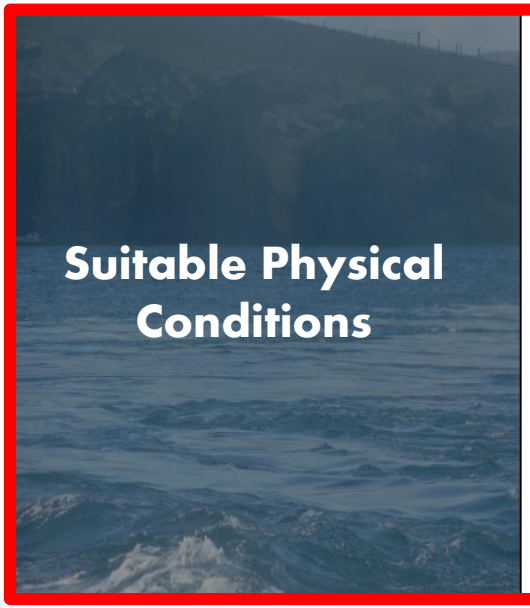
FLOWBEC frame (single point, temporal persistence)

complemented by

RESPONSE boat surveys (entire site, temporal snapshot)

Waggitt *et al.* (2014) EIMR





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Investigating the ecological effects of installing and operating MREDs

- Investigate collision risk probabilities
- Define vertical habitat use and any changes in habitat use pre & post installation for a range of species
- Increase overall environmental understanding of mobile animal use of high energy sites
- Inform marine spatial planning, device design, licensing and operation
- Guide scaling-up to arrays and new site selection
- Increase predictive power to eventually reduce monitoring

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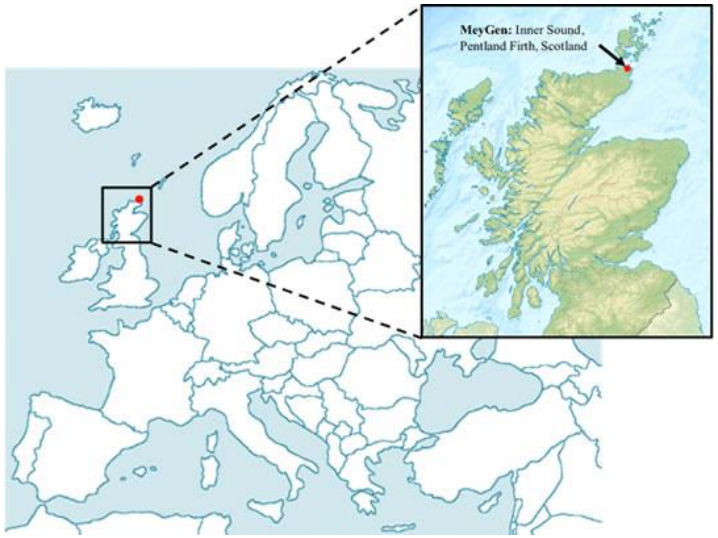
Environmental Monitoring at MeyGen (UK)

Staged consent:

- 4 turbines, construction started
- then 61 turbines (86 MW)
- eventually 398 MW



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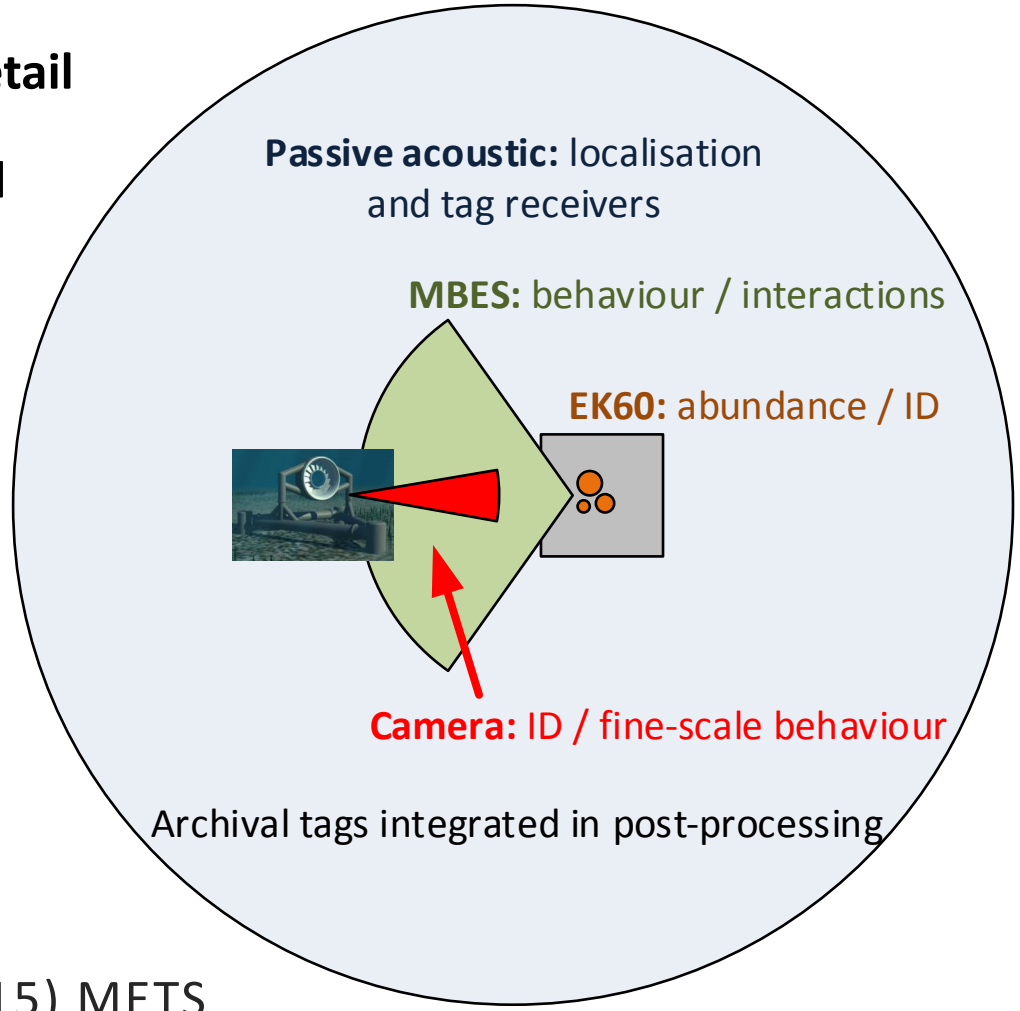
Environmental Monitoring at MeyGen (UK)

Intelligent triggering of instruments across **multiple scales**

- Combines **large-scale** with **fine-detail**
- Reduces data processing / archival
- Cycle passive / active acoustics
- Trigger camera for ID / detail



Cotter, Williamson and Polagye (2015) METS

Williamson, B.J. *et al.* 2015. A Self-Contained Subsea Platform for Acoustic Monitoring of the Environment Around Marine Renewable Energy Devices – Field Deployments at Wave and Tidal Energy Sites in Orkney, Scotland. *IEEE Journal of Oceanic Engineering* 10.1109/JOE.2015.2410851

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